16th IAEA International Conference on Plasma Physics and Controlled Nuclear Fusion Research: Oct. 7 - Oct. 11, 1996

Paper # -

LASER SCATTERING IN LARGE-SCALE-LENGTH PLASMAS RELEVANT TO NATIONAL IGNITION FACILITY HOHLRAUMS*

B.J. MacGOWAN
Lawrence Livermore National Laboratory, University of California, L-473 P.O. Box 808, Livermore, California 94550, U.S.A.

The understanding of laser plasma interactions within ignition-scale inertial confinement fusion (ICF) hohlraum targets is central to the success of the proposed National Ignition Facility (NIF). We have used homogeneous plasmas of high density (up to 1.5 10^{21} electrons per cm^3) and temperature (~ 3 keV) with large density scalelengths (~2 mm) in order to approximate conditions within National Ignition Facility scale hohlraums. Using these plasmas we have studied the dependence of stimulated Raman (SRS) and Brillouin (SBS) scattering on beam smoothing and plasma conditions at the NIF relevant laser intensity (3ω, 2 $10^{15}$$Wcm^{-2}$). Narrowly collimated SRS has been observed from low-Z plasmas which are representative of the plasma filling most of the ignition-scale hohlraum, while SBS backscatter occurs in the high-Z plasma of gold ablated from the hohlraum wall. Both SBS and SRS are reduced by use of smoothing by spectral dispersion (SSD). We present results of experiments and calculations investigating the degree of beam smoothing that will be required on the NIF.
We have investigated the effect of damping on the stimulated scattering processes in several experiments. (1) Electron Landau damping of SRS was modified by varying plasma temperature and density with the result that SRS reflectivity reduced as damping was increased, consistent with linear theory. (2) Ion Landau damping of the acoustic waves produced by SBS was varied by modifying the concentration of light dopant ions within the plasma. In weakly damped "high-Z" plasmas (e.g. pure CO_2, Au or Xe) the SBS was observed to decrease as lighter ions were added (H or Be), again in accordance with linear theory. However the reduction in ion wave damping also produced an increase in SRS reflectivity, consistent with the interpretation that SRS is being limited by the Parametric Decay of the electron plasma wave, which is dependent on ion wave damping. (3) Other experiments studying the interplay between SBS and SRS, when ion damping is held constant, have shown that they are anticorrelated as the density of the target is varied (altering electron Landau damping). Low density plasmas (7% - 9%$n_{critical}$) show SBS dominating over SRS while experiments at higher density (10% - 15%$n_{critical}$) show SRS dominating over SBS (by 4 orders of magnitude at the higher density). Linear theory indicates that SBS gain should be higher in the higher density plasmas, while the experiments show a dramatic reduction in SBS at high density. The results imply that SRS determined by electron Landau damping controls SBS in our large scale length plasmas, only allowing SBS to grow when SRS is too heavily damped to occur. The significance of the results of these different experiments will be discussed.
The understanding of filamentation, SRS, and SBS in ICF relevant plasmas is a crucial part of the preparation for demonstration of ignition. The results presented here will quantify our ability to control and understand such instabilities in homogeneous plasmas for irradiances at, and above, those planned for the NIF.

*This work was performed under the auspices of the US. Department of Energy by the Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48.

Prefer poster session

Brian J. MacGowan
L-473
LLNL
P.O.Box 808
Livermore, Ca 94550
Internet MacGowan@LLNL.GOV